CLAIMS

1. A mixture for etching a dielectric material in a layered substrate, the mixture comprising:

an unsaturated oxygenated fluorocarbon having the formula $C_xF_yO_zR_q$ wherein R is a hydrogen atom, a hydrocarbyl group having a number of carbon atoms ranging from 1 to 5, a halocarbyl group having a number of carbon atoms ranging from 1 to 5, or a halohydrocarbyl group having a number of carbon atoms ranging from 1 to 5; x is a number ranging from 2 to 10; y is a number less than 2x-q, z is a number ranging from 1 to 2; and q is a number ranging from 0 to 1, and wherein the ratio of F atoms to C atoms is less than 2,

provided that when x is a number ranging from 3 to 10, y is a number less than 2x-q, z is 1, and q is 0, the mixture further comprises an oxidizer wherein the ratio by volume of the oxidizer to the unsaturated oxygenated fluorocarbon ranges from 0:1 to 1.0:1.

2. The mixture further comprising at least one inert diluent gas selected from the group consisting of argon, neon, xenon, helium, nitrogen, krypton, and combinations thereof.

3. The mixture of claim 1 wherein the mixture comprises from 0.1 to 99% by volume of the inert diluent gas.

4. The mixture of claim 1 wherein the unsaturated oxygenated fluorocarbon is at least one compound selected from the group consisting of epoxides, diepoxides, ketones, diketones, esters, ethers, acyl fluorides, diacyl fluorides, alcohols, aldehydes, peroxides, and combinations thereof.

5. The mixture of claim 1 wherein the oxidizer is at least one selected from the group consisting of O_3, O_2, CO, CO_2, N_2O and combinations thereof.

6. The mixture of claim 1 wherein the mixture comprises 1 to 99% by volume of the unsaturated oxygenated fluorocarbon.

7. The mixture of claim 1 wherein the mixture comprises 0 to 99% by volume of the oxidizer.

8. The mixture of claim 1 wherein the dielectric material is comprised of at least one selected from the group consisting of silicon, compositions comprising silicon, silicon dioxide (SiO_2), undoped silicon glass (USG), doped silica glass, silicon and nitride containing materials, organosilicate glass (OSG), organofluoro-silicate glass (OFSG), low dielectric constant materials, polymeric materials, porous low dielectric constant materials, and combinations thereof.

9. A mixture for removing a portion of a dielectric material in a layered substrate comprising an unsaturated oxygenated fluorocarbon comprising an epoxide having the formula $C_xF_yO_z$ wherein x is a number ranging from 3 to 10; y is a number less than 2x-q; and z is 1 and wherein the ratio of F atoms to C atoms is less than 2.

10. A mixture for removing a portion of a dielectric material in a layered substrate comprising an unsaturated oxygenated fluorocarbon comprising a diepoxide having the formula $C_xF_yO_z$ wherein x is a number ranging from 4 to 10; y is a number less than 2x-q; z is 2; and wherein the ratio of F atoms to C atoms is less than 2.

11. A mixture for removing a portion of a dielectric material in a layered substrate comprising an unsaturated oxygenated fluorocarbon comprising a ketone having the formula $C_xF_yO_z$ wherein x is a number ranging from 3 to 10; y is a number less than 2x-q; and z is 1 wherein the ratio of F atoms to C atoms is less than 2, and an oxidizer wherein the ratio by volume of oxidizer to the unsaturated oxygenated from 0:1 to 1.0:1.

12. A mixture for removing a portion of a dielectric material in a layered substrate comprising an unsaturated oxygenated fluorocarbon comprising a diketone having the formula $C_xF_yO_z$ wherein x is a number ranging from 4 to 10; y is a number less than 2x-q; z is 2, and wherein the ratio of F atoms to C atoms is less than 2.

13. A mixture for removing a portion of a dielectric material in a layered substrate comprising an unsaturated oxygenated fluorocarbon comprising an ester having the formula $C_xF_yO_zR_q$ wherein R is a hydrocarbyl group having a number of carbon atoms ranging from 1 to 5, a halocarbyl group having a number of carbon atoms ranging from 1 to 5, or a halohydrocarbyl group having a number of carbon atoms ranging from 1 to 5; x is a number ranging from 2 to 10; y is a number less than 2x-q; z is 2; and q is 1, and wherein the ratio of F atoms to C atoms is less than 2.

14. A mixture for removing a portion of a dielectric material in a layered substrate comprising an unsaturated oxygenated fluorocarbon comprising an ether having the formula $C_xF_yO_zR_q$ wherein R is a hydrocarbyl group having a number of carbon atoms ranging from 1 to 5, a halocarbyl group having a number of carbon atoms ranging from 1 to 5; or a halohydrocarbyl group having a number of carbon atoms ranging from 1 to 5; x is a number ranging from 2 to 10; y is a number less than 2x-q; z is 1; and q is 1, and wherein the ratio of F atoms to C atoms is less than 2.

15. A mixture for removing a portion of a dielectric material in a layered substrate comprising an unsaturated oxygenated fluorocarbon comprising an acyl fluoride having the formula $C_xF_yO_z$ wherein x is a number ranging from 2 to 10; y is a number less than 2x-q; and z is 1; and wherein the ratio of F atoms to C atoms is less than 2.

16. A mixture for removing a portion of a dielectric material in a layered substrate comprising an unsaturated oxygenated fluorocarbon comprising a diacyl fluoride having the formula $C_xF_yO_z$ wherein x is a number ranging from 3 to 10; y is a number less than 2x-q, z is 2, and wherein the ratio of F atoms to C atoms is less than 2.

17. A mixture for removing a portion of a dielectric material in a layered substrate comprising an unsaturated oxygenated fluorocarbon comprising an alcohol having the formula $C_xF_yO_zR_q$ wherein R_q = H, x is a number ranging from 2 to 10; y is a number less than 2x-q; z is 1; and q is 1, and wherein the ratio of F atoms to C atoms is less than 2.

18. A mixture for removing a portion of a dielectric material in a layered substrate comprising an unsaturated oxygenated fluorocarbon comprising an aldehyde having the formula $C_xF_yO_z$ wherein x is a number ranging from 2 to 10; y is a number less than 2x-q; z is 1 and at least one hydrogen atom bond to a carbonyl carbon and wherein the ratio of F atoms to C atoms is less than 2.

19. A mixture for removing a portion of a dielectric material in a layered substrate comprising an unsaturated oxygenated fluorocarbon comprising a peroxide having the formula $C_xF_yO_zR_q$ wherein R is a hydrogen atom, a hydrocarbyl group having a number of carbon atoms ranging from 1 to 5, a halocarbyl group having a number of carbon atoms ranging from 1 to 5, or a halohydrocarbyl group having a number of carbon atoms ranging from 1 to 5; x is a number ranging from 2 to 10; y is a number less than 2x-q; z is 2; and q is a number ranging from 0 to 1, and wherein the ratio of F atoms to C atoms is less than 2.

20. A method for the removal of a portion of a dielectric material from a layered substrate, the method comprising:

providing a gas mixture comprising an unsaturated oxygenated fluorocarbon having the formula $C_xF_yO_zR_q$ wherein R is a hydrogen atom, a hydrocarbyl group having a number of carbon atoms ranging from 1 to 5, a halocarbyl group having a number of carbon atoms ranging from 1 to 5, or a halohydrocarbyl group having a number of carbon atoms ranging from 1 to 5; x is a number ranging from 2 to 10; y is a number less than 2x-q; z is a number ranging from 1 to 2; and q is a number ranging from 0 to 1, and wherein the ratio of F atoms to C atoms is less than 2, provided that when x is a number ranging

from 3 to 10; y is a number less than 2x-q; z is 1; and q is 0, the mixture further comprises an oxidizer wherein the ratio by volume of the oxidizer to the unsaturated oxygenated fluorocarbon ranges from 0:1 to 1.0:1;

applying energy to the gas mixture to form active species; and

contacting the layered substrate with the active species to remove the portion of the dielectric material.

21. The method of claim 20 wherein the gas mixture has a pressure ranging from 0.1 to 10,000 mTorr.

22. The method of claim 20 wherein the flow rate of the gas mixture ranges from 10 to 50,000 standard cubic centimeters per minute (sccm).

23. The method of claim 20 wherein the gas mixture is provided through at least one method selected from the group consisting of conventional cylinders, safe delivery systems, vacuum delivery systems, solid-based generators, liquid-based generators, point of use generators, and combinations thereof.

24. A method for etching at least a portion of a dielectric material from a layered substrate, the method comprising:

providing a mixture comprising an unsaturated oxygenated fluorocarbon having the formula $C_xF_yO_zR_q$

wherein R is a hydrogen atom, a hydrocarbyl group having a number of carbon atoms ranging from 1 to 5, a halocarbyl group having a number of carbon atoms ranging from 1 to 5, or a halohydrocarbyl group having a number of carbon atoms ranging from 1 to 5; x is a number ranging from 2 to 10; y is a number less than 2x-q; z is a number ranging from 1 to 2; and q is a number ranging from 0 to 1,

wherein the F/C ratio is less than 2, and

wherein the ratio by volume of the oxidizer to the unsaturated oxygenated fluorocarbon ranges from 0:1 to 1.0:1; and

contacting the layered substrate with the mixture to at least partially react with and removes the at least a portion of the dielectric material.

25. A method for forming an epoxide having the formula $C_xF_yO_z$ wherein x is a number ranging from 3 to 10; y is a number less than 2x-q; and z is 1 and wherein the ratio of F atoms to C atoms is less than 2, the method comprising:

providing a reaction mixture comprising at least one solvent and a hypochlorite;

adding at least one fluoroolefin comprising at least one double bond and having the formula $C_\alpha F_\beta$ where $\beta < 2\alpha$ to the reaction mixture to at least partially react and form the epoxide; and

removing at least a portion of the epoxide prior to the completion of the adding step.